Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands	)	WT Docket No. 02-146
	)	
	)	
Loea Communications Corporation Petition for Rulemaking	)	RM-10288
	)	

REPORT AND ORDER

Adopted: October 16, 2003 **Released: November 4, 2003**

By the Commission: Chairman Powell and Commissioners Copps, Martin and Adelstein issuing separate statements.

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I. INTRODUCTION AND EXECUTIVE SUMMARY

1. In this *Report and Order*, we adopt service rules to promote the private sector development and use of the "millimeter wave" spectrum in the 71-76 GHz, 81-86 GHz and 92-95 GHz bands[1] pursuant to Parts 15 and 101 of our Rules. This action follows an initiative by our Office of Engineering and Technology (OET) to spawn possible commercial development of these bands under the Communications Act of 1934, as amended (Act).[2] By this action, we (1) provide a flexible and streamlined regulatory framework that will encourage innovative uses of the spectrum; (2) accommodate potential future developments in technology and equipment; (3) promote competition in the communications services, equipment and related markets; and (4) advance potential spectrum sharing between non-Federal Government and Federal Government[3] systems.[4] Additionally, we anticipate that the actions we take today will encourage the use of technologies developed by our military and scientific community in a broad range of new products and services, such as high-speed wireless local area networks, and increase access to broadband services, including access systems for the Internet.

2. In the *Report and Order* we make the following major decisions:

- We reallocate the 71-76 GHz, 81-86 GHz and 92-95 GHz bands to update the current allocations, which were established at the World Administration Radio Conference in 1992 (WARC-92, Malaga-Torremolinos) and the World Radiocommunication Conference in 1997 and 2000 (WRC-97, Geneva, and WRC-2000, Istanbul).

- We divide the 71-76 GHz and 81-86 GHz bands into four unpaired 1.25 GHz segments each (eight total), without mandating specific channels within the segment. The segments may be aggregated without limit.

- Non-Federal Government licensees will receive non-exclusive nationwide licenses authorizing operation on all 12.9 GHz of co-primary spectrum. Rights with regard to specific

[1] The term "millimeter wave" is derived from the wavelengths of radio frequency signals between 30 GHz and 300 GHz, which range between 1 and 10 millimeters. The term "bands" generally refers to the combined 71-76, 81-86 and 92-95 GHz bands. If a band is discussed separately, or a discussion pertains to two of the three segments, then the specific segment(s) will be referenced (*e.g.*, 71-76 GHz band, 71-76 GHz and 81-86 GHz bands).

[2] 47 U.S.C. §§ 301, 303 and 309.

[3] In the context of spectrum management, "Federal Government" refers to use by the Federal Government and "non-Federal Government" refers to use by private entities and state and local governments.

[4] 47 U.S.C. §§ 301, 303 and 309.

links will be established based upon the date and time of link registration. Initially, coordination of non-Federal Government links with Federal Government operations will be accomplished under the existing coordination process, and non-Federal Government links will be recorded in the Commission's Universal Licensing System database. On a permanent basis, such coordination will be accomplished within a new process for coordination of non-Federal Government links with Federal Government users. We envision that coordination will be accomplished via an automated mechanism administered by the National Telecommunications and Information Administration (NTIA), for which the framework will be jointly agreed by the FCC and NTIA. Within four months of the publication of this *Report and Order* in the *Federal Register*, Commission staff, in conjunction with the NTIA, will release a *public notice* setting out the implementation of a new process for coordination of non-Federal Government links with Federal Government users. NTIA has indicated that it believes that it can make the initial version of the mechanism available within 4 months of the *public notice*. In addition, at that time, Commission staff will announce via *public notice* the start-date for the new procedure that we adopt herein for mitigating interference among non-Federal Government links.

- We permit unlicensed non-Federal Government indoor use of the 92-95 GHz band, to be governed by rules based on existing regulations for the 57-64 GHz band.

- We decline to adopt eligibility restrictions for the 71-76 GHz, 81-86 GHz, and 92-95 GHz bands.

II. BACKGROUND

3. The use of wireless frequencies by entities regulated by the Commission is subject to two primary types of regulatory oversight: an allocation of spectrum and rules to govern the operations in the spectrum. Spectrum allocations are set forth in the United States Table of Allocations (U.S. Table) in Section 2.106 of our Rules.[5] The U.S. Table now extends up to 300 GHz and specifies the types of services for which each band may be used. Service rules describe the specific technical standards and licensing criteria to be used for licensed services; operation of unlicensed devices is governed by technical standards and related provisions.[6] At present, the highest frequencies for which we authorize licensed services are in the 48.2-50.2 GHz band, and the highest frequencies at which unlicensed devices may operate are in the 76-77 GHz band.[7] Thus, currently, radio technology that operates above 50.2 GHz may not be licensed except on an experimental basis under Part 5 of our rules,[8] and devices for operation above 77 GHz on either a licensed or unlicensed basis may not be marketed.[9]

[5] 47 C.F.R. § 2.106.

[6] Unlicensed devices that intentionally emit radio frequency energy are regulated under Part 15 of our Rules. 47 C.F.R. Part 15. Part 15 Rules specify limits on the power and operating characteristics of these devices that are designed to avoid the potential for such devices to cause interference. These rules also generally provide that unlicensed devices may not cause interference and must accept interference from other radio transmitters.

[7] 47 C.F.R. §§ 15.253, 25.202(a)(1). Consistent with their class of licenses, Amateur licensees are permitted to use various bands allocated to the Amateur Service without authorization for specific frequencies.

[8] 47 C.F.R. § 5.01 *et seq*. These rules permit simplified licensing of spectrum for experiments that would not otherwise be permitted under our Rules. In general, equipment may not be marketed in connection with such experiments, and service may not be provided for commercial use. However, our rules permit "limited market (continued....)

4. In July 2000, the Commission held a public forum on possible new uses of the 92-95 GHz band.[10] Several speakers at the forum indicated that due to recent technological developments, new uses of this band are approaching practicality. In addition, in July 2001 Loea Communications Corporation (Loea) experimented with technology it developed for use of the 71-76 GHz and 81-86 GHz bands.[11] As a result, Loea filed a petition requesting the establishment of service rules for the licensed use of the 71-76 GHz and 81-86 GHz bands on September 10, 2001.[12] On June 28, 2002, the Commission proposed rules to allow use of the 71-76 GHz, 81-86 GHz, 92-94 GHz and 94.1-95 (92-95) GHz bands for a broad range of new fixed and mobile services, and sought comment on its proposals.[13] Those proposals included allocation changes to the bands as well as provisions to ensure that new non-Federal Government operations can share the available frequencies with Federal Government operations in the 71-76 GHz, 81-86 GHz, 92-94 GHz and 94.1-95 GHz bands and protect operations in adjacent bands. Today, we establish the allocation, band plan, service rules, and technical standards for these bands.

III. DISCUSSION

5. The 71-76 GHz, 81-86 GHz and 92-95 GHz bands are essentially undeveloped and available for new uses.[14] Generally, it has been our experience that opening new regions of the spectrum to new applications and technologies fosters the development of new communications products and services for the public and the concomitant economic growth and jobs.[15] Following our experience in other spectrum regions, we believe that opening portions of the millimeter wave spectrum could stimulate new applications of radio technology, facilitate technology transfer from the military, and create new opportunities for economic growth and jobs. This action will also promote United States competitiveness internationally by enabling the development of technology for potential international use.

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studies" that permit marketing on a small scale within the context of "limited market studies" in connection with experiments. *See* 47 C.F.R. § 5.93.

[9] No licensed service rules address frequency use above 50.2 GHz. The highest frequency specifically authorized for unlicensed use is 77 GHz, which is used for vehicular radar systems, 47 C.F.R. § 15.253.

[10] *See* Office of Engineering and Technology to Host Forum on 90 GHz Technologies, *Public Notice,* 15 FCC Rcd 18,693 (OET 2000).

[11] *See* Loea Communications Corp. Petition for Rulemaking at 4 (filed Sept. 10, 2001)(Loea Petition).

[12] *See id.*

[13] Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, *Notice of Proposed Rule Making,* WT Docket No. 02-146, RM-10288, 17 FCC Rcd 12,182 (2002)(*NPRM*).

[14] *Id.* at 12,188 ¶ 10. For additional background information regarding these bands, see *id.* at 12,185-90 ¶¶ 5-13.

[15] *See* Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, *First Report and Order and Third Notice of Proposed Rule Making*, ET Docket No. 92-9, 7 FCC Rcd 6886 (1992) (reallocating portions of the 2 GHz from fixed microwave services to emerging technology systems, including personal communications services (PCS)); Authorization of Spread Spectrum and Other Wideband Emissions not Presently Provided for in the FCC Rules and Regulations, *First Report and Order,* GEN Docket No. 81-413, 101 FCC 2d 419 (1985) (adopting rules in Part 15 for low power spread spectrum devices).

A. Allocation

1. 71-76 GHz

6. *Background.* WRC-2000 allocated the 81-86 GHz band to the Radio Astronomy Service (RAS)[16] on a primary basis. In order to avoid having satellite downlinks in the 81-84 GHz band, which would cause harmful interference to the new primary RAS allocation, the Mobile-Satellite Service (MSS) and Fixed-Satellite Service (FSS) uplink allocations in the 71-74 GHz band were interchanged with the MSS and FSS downlink allocations in the 81-84 GHz band. WRC-2000 also deleted the 72.77-72.91 GHz band from footnotes 5.149 and 5.556[17] and added RAS allocations above 76 GHz.

7. In the *NPRM,* the Commission proposed to implement the *WARC-92 Final Acts* and most of the *WRC-2000 Final Acts* with respect to the 71-76 GHz band.[18] Specifically, the Commission proposed to change the FSS directional indicator in the 71-75.5 GHz band and the MSS directional indicator in the 71-74 GHz band from uplinks to downlinks.[19] As a consequence of the proposal to change the FSS directional indicator in the 74-75.5 GHz band, the Commission proposed to revise footnote US297[20] in order to state that 81-82.5 GHz (instead of 74-75.5 GHz) is available for Broadcast-Satellite Service (BSS) feeder links.[21] The Commission proposed to delete the RAS allocation from the 72.77-72.91 GHz band by removing footnote US270[22] from the Table.[23] It also proposed to allocate the 74-76 GHz band to the BSS and broadcasting service on a primary basis and for space research service (SRS) downlinks on a secondary basis.[24]

8. Further, the Commission proposed to allocate the 75.5-76 GHz band to the fixed, mobile, and FSS downlink services on a primary basis and to delete the amateur[25] and amateur-satellite service[26]

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[16] The Radio Astronomy Service is astronomy based on the reception of radio waves of cosmic origin. *See* 47 C.F.R. § 2.1.

[17] Footnote 5.556 stated that radio astronomy observations could be carried out under national arrangements in the 72.77-72.91 GHz band and, in making assignments to stations of other services, footnote 5.149 urged administrations to take all practical steps to protect the RAS in this band from harmful interference. *See* 47 C.F.R. § 2.106 nn.5.149, 5.556.

[18] *See NPRM,* 17 FCC Rcd at 12,191 ¶ 20.

[19] *Id.*

[20] 47 C.F.R. § 2.106 n.US297.

[21] *See NPRM,* 17 FCC Rcd at 12,192 ¶ 20. BSS feeder links are uplinks to BSS satellites and are performed in FSS allocations. Feeder links are used to send programming to the satellite for retransmission on BSS downlink frequencies.

[22] 47 C.F.R. § 2.106 n.US270.

[23] *See NPRM,* 17 FCC Rcd at 12,191 ¶ 20.

[24] The BSS and broadcasting service are regulated solely by the Commission and thus, these allocations will be added only to the non-Federal Government Table.

[25] The Amateur service is a generally a radiocommunication service carried out by authorized individuals for personal aim without pecuniary interest. 47 C.F.R. § 97.1(a)(4).

allocations from this band.[27] The Commission proposed to permit the amateur and amateur-satellite services in the 75.5-76 GHz band to continue on a secondary basis until January 1, 2006, rather than to adopt footnote 5.559A, which would allow these services to operate on a primary basis until 2006.[28] In order to implement this proposal, the Commission proposed to add a new frequency sharing requirement to Section 97.303 of our Rules,[29] which would read as follows:

> No amateur or amateur-satellite station transmitting in the 75.5-76 GHz segment shall cause interference to, nor claim protection from interference due to the operation of, stations in the Fixed Service (FS). After January 1, 2006, the 75.5-76 GHz segment is no longer allocated to the amateur service or to the amateur-satellite service.[30]

9. In response to a request by the National Telecommunications and Information Administration (NTIA) to protect future Federal Government use, the Commission proposed to adopt the following United States footnote:

> USwww In the band 74-76 GHz, stations in the fixed, mobile and broadcasting services shall not cause harmful interference to stations of the Federal Government fixed-satellite service.[31]

The Commission requested comment on the above proposals and whether similar protection should be provided to non-Federal FSS and BSS operations.[32] The Commission determined that if both satellite and terrestrial allocations are implemented in the 71-76 GHz band, then technical and regulatory guidelines will be necessary to allow spectrum sharing. Thus, it sought comment on what requirements would be necessary to facilitate sharing between the various services, such as coordination requirements and power flux-density (PFD) limits for satellite operations in the 71-76 GHz band.[33] The Commission also requested comment on whether any coordination requirements adopted to facilitate sharing would eliminate the need for the footnote to protect future FSS use, thus placing all allocations on equal footing.[34]

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[26] The Amateur-satellite service is a radiocommunication service using stations on Earth satellites for the same purpose as those of the amateur service. 47 C.F.R. § 97.1(a)(3). *See supra,* n. 25.

[27] *See NPRM,* 17 FCC Rcd at 12,191 ¶ 20. The amateur and amateur-satellite services allocations are regulated solely by the Commission. Our proposed allocation changes are to be made only to the non-Federal Government Table.

[28] *Id.* at 12,192 ¶ 23.

[29] 47 C.F.R. § 97.303.

[30] *NPRM,* 17 FCC Rcd at 12,192 ¶ 24.

[31] *Id.*

[32] *Id.* at 12,191 ¶ 22.

[33] *Id.*

[34] *Id.*

10. *Discussion.* Commenters generally supported the Commission's proposals to implement the WARC-92 and WRC-2000 *Final Acts*.[35] While Canada and other administrations have implemented the secondary SRS downlink allocation in the 74-76 GHz band from WARC-92,[36] international implementation of the WRC-2000 *Final Acts* appears to be just commencing.[37] We agree that these changes are appropriate and will simplify coordination among satellite, terrestrial, and broadcast services. Consequently, we adopt the proposed changes to the U.S. Table. Accordingly, the 71-76 GHz band is allocated to the fixed, fixed-satellite (space-to-Earth), and mobile services on a primary basis; the 71-74 GHz band is additionally allocated to the mobile-satellite (space–to-Earth) on a primary basis; and the 74-76 GHz band is additionally allocated to the broadcasting and broadcasting-satellite services on a primary basis and to the space research service (space–to-Earth) on a secondary basis. All of these allocations will be available for both Federal and non-Federal Government use, except for the broadcasting and broadcasting-satellite service allocations, which are limited to non-Federal Government use.

11. In the matter of amateur radio sharing of the 71-76 GHz band, the Wireless Communications Association International, Inc. (WCAI) and The Boeing Company (Boeing) agree that the amateur and amateur-satellite operations in the 75.5-76 GHz band should be permitted only on a secondary basis.[38] The *NPRM* states that it is unclear whether the 75.5-76 GHz amateur radio band is being used. Amateurs state that there is documentary evidence of recent use of 75 GHz and higher frequencies by amateur radio operators.[39] However, as Boeing notes, amateur radio operators have access to the adjacent 77 GHz band.[40] Therefore, we conclude that moving these operations out of the 75.5-76 GHz band would not pose a major inconvenience to amateur radio, but would substantially benefit future fixed services, because it would eliminate the possibility of harmful interference from amateurs. Accordingly, the primary allocations to the amateur and amateur-satellite services in the 75.5-76 GHz band are downgraded from primary to secondary status. Secondary use will cease on January 1, 2006. We codify this transition plan in footnote US387 and in Section 97.303(r)(3) of our amateur service rules.

12. The Commission requested comments regarding sharing of the 71-76 GHz band, and protection to non-Federal Government FSS and BSS operations. Boeing indicated that it is premature to adopt satellite downlink PFD limits in the upper millimeter-wave frequencies above 70 GHz, to facilitate

[35] The Wireless Communications Association International, Inc. (WCAI) Comments at 2, 5, 25; Loea Comments at 32; The Boeing Company (Boeing) Comments at 2; NTIA's "For IRAC Review on Feb 26, 2002", at 1.

[36] *See, e.g., Canadian Table of Frequency Allocations 9 kHz to 275 GHz* (Industry Canada, December 2000). WARC-92 allocated the 74-84 GHz band to the space research service (space-to-Earth) on a secondary basis.

[37] The European Common Table has been updated to reflect the Above 71 GHz realignment in the *WRC-2000 Final Acts.* "Although the implementation of this Table has been arranged for the year 2008 it is expected that the European Conference of Postal and Telecommunications Administrations (CEPT) member countries will endeavor to implement, as soon as possible, as many parts of the Table as they are able." *The European Table of Frequency Allocations and Utilizations Covering the Frequency Range 9 kHz To 275 GHz* at 3 (European Radiocommunications Committee (ERC), eds., 2002, rev. 2003). In April 2002, Canada proposed to update its Table to reflect the Above 71 GHz realignment, but it has not been finalized. *Proposed Revisions to the Canadian Table of Frequency Allocations,* (Industry Canada, eds., 2002).

[38] WCAI Comments at 5; Boeing Comments at 2.

[39] Leggett Comments, Set 2 at 1-2, and Appendix A.

[40] Boeing Comments at 2.

sharing of the 71-76 GHz band,[41] and suggested the domestic adoption of a modified footnote USwww to be applicable to the entire 71-76 GHz frequency band to protect both Federal Government and non-Federal Government satellite receive earth stations from earlier deployment of fixed stations in this upper millimeter-wave spectrum. On the basis of ongoing discussions with NTIA and the Commission, we have modified and re-numbered proposed footnote USwww as to read as follows:

> US389 In the bands 71-76 GHz and 81-86 GHz, stations in the fixed, mobile, and broadcasting services shall not cause harmful interference to, nor claim protection from, Federal Government stations in the fixed-satellite service at any of the following 28 military installations:

Military Installation	State	Nearby city
Redstone Arsenal	AL	Huntsville
Fort Huachuca	AZ	Sierra Vista
Yuma Proving Ground	AZ	Yuma
Beale AFB	CA	Marysville
Camp Parks Reserve Forces Training Area	CA	Dublin
China Lake Naval Air Weapons Station	CA	Ridgecrest
Edwards AFB	CA	Rosamond
Fort Irwin	CA	Barstow
Marine Corps Air Ground Combat Center	CA	Twentynine Palms
Buckley AFB	CO	Aurora (Denver)
Schriever AFB	CO	Colorado Springs
Fort Gordon	GA	Augusta
Naval Satellite Operations Center	GU	Finegayan (Territory of Guam)
Naval Computer and Telecommunications Area Master Station, Pacific	HI	Wahiawa (Oahu Is.)
Fort Detrick	MD	Frederick
Nellis AFB	NV	Las Vegas
Nevada Test Site	NV	Amargosa Valley
Tonapah Test Range Airfield	NV	Tonapah
Cannon AFB	NM	Clovis
White Sands Missile Range	NM	White Sands
Dyess AFB	TX	Abilene
Fort Bliss	TX	El Paso
Fort Sam Houston	TX	San Antonio
Goodfellow AFB	TX	San Angelo
Kelly AFB	TX	San Antonio
Utah Test and Training Range	UT	.....
Fort Belvoir	VA	Alexandria
Naval Satellite Operations Center	VA	Chesapeake

We believe that the originally proposed footnote was broader than necessary to protect critical Federal Government operations; however, we believe that a narrower footnote as proposed by NTIA will sufficiently protect Federal Government operations and maximize non-Federal Government use. Federal Government fixed-satellite service systems may operate at locations other than those identified above. Coordination between Federal Government fixed-satellite service systems and non-Federal Government space and terrestrial systems operating in accordance with the United States Table of Allocations is required at all locations.

[41] *Id.* at 4.

13. Cisco Systems, Inc. (Cisco) does not oppose the Commission's footnote USwww as proposed in the *NPRM* because it assumes that Federal Government FSS operations would involve a relatively small number of earth stations at relatively remote locations (rather than major metropolitan areas).[42] On the other hand, because there are no assurances that these assumptions are correct, it cannot affirmatively support that proposed footnote at this time. Before a footnote is adopted, Cisco believes that current or potential Federal Government users should give the Commission information regarding the scope and location of FSS operations in the 74-76 GHz band. Based on this information, Cisco would like the Commission to formulate limitations on the footnote that will give fixed, mobile and broadcasting users the confidence to make rational investments in a radio link. Cisco supports making FSS and BSS allocations,[43] but opposes, jointly with Loea,[44] Boeing's version of a new footnote USwww to the table of allocations.[45] Except as noted in the preceding paragraph regarding Federal Government fixed satellite services, we conclude that the technology and use of the 71-76 GHz band need to mature to allow us to arrive at the correct parameters for sharing of the band, so it would be premature to adopt any version of footnote USwww with respect to the non-Federal Government fixed satellite service.

14. With regard to mobile use, Cisco and the Fixed Wireless Communications Coalition (FWCC) assert that mobile use of the 71-76 GHz band is incompatible with fixed service.[46] These commenters believe that the allocation for mobile use should be postponed until the Commission develops a record concerning predictions about interference.[47] We concur that there is currently not enough data to arrive at interference predictions in the 71-76 GHz band. However, we believe that the appropriate course of action is to not change the allocation now, but defer adoption of rules for operation of terrestrial mobile services until inter-service interference issues are resolved. We believe this will foster innovation and will give licensees the opportunity to make use of technological advances in order to develop ways to use this band for mobile operations. Furthermore, we note that this action is consistent with that taken regarding mobile services in the 39 GHz band.[48] Thus, the approach we take here with respect to the mobile allocation is not unprecedented.

2. 81-86 GHz

15. *Background.* In the *NPRM,* the Commission proposed to implement the *WARC-92 Final Acts* and most of the *WRC-2000 Final Acts* with respect to the 81-86 GHz band.[49] Specifically, the Commission proposed to allocate the 81-86 GHz band to the RAS on a primary basis, to change the directional indicators on the FSS and MSS allocations in the 81-84 GHz band from downlinks to uplinks,

[42] Cisco Systems, Inc. (Cisco) Comments at 8.

[43] Cisco Reply at 4.

[44] Loea Reply at 4-7

[45] Cisco Reply at 4-5.

[46] *See, e.g.,* Cisco Reply at 3; FWCC Comments at 6.

[47] Cisco Reply at 3.

[48] *See* Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands, *Report and Order and Second Notice of Proposed Rule Making*, 12 FCC Rcd 18,600, 18,617-19 ¶¶ 30-33 (*39 GHz R&O*) (1997).

[49] *NPRM,* 17 FCC Rcd at 12,194 ¶ 30.

to allocate the 84-86 GHz band for FSS uplinks, and to delete the BSS and broadcasting allocations from the 84-86 GHz band.[50] The Commission proposed to revise footnote US297 to state that 81-82.5 GHz (instead of 74-75.5 GHz) is available for BSS feeder links. It also proposed to revise footnote US211 by deleting the 84-86 GHz band from those bands in which applicants for airborne or space station assignments are urged to take all practicable steps to protect RAS observations in adjacent bands from harmful interference,[51] and to revise footnote US342 in order to add the 81-86 GHz band to the list of frequency bands wherein all practicable steps are to be taken to protect the RAS from harmful interference when assignments to stations in other services are made.[52]

16. The Commission requested comment on whether footnote 5.561A, which would allocate the 81-81.5 GHz band to the amateur and amateur-satellite services on a secondary basis, should be adopted domestically.[53] The Commission has previously allocated the 77.5-78 GHz band to the amateur and amateur-satellite services on a primary basis. It therefore sought comment on whether these secondary allocations are needed. Further, it requested comment on whether amateur and amateur-satellite services in the 81-81.5 GHz band would be compatible with primary commercial operations.[54]

17. *Discussion*. As discussed previously, commenters generally supported the Commission's proposals to implement the WARC-92 and WRC-2000 *Final Acts*.[55] We believe that these changes are appropriate, and will eliminate prospective interference to satellite operations. Consequently, we adopt the proposed changes to the U.S. Table. Accordingly, the 81-86 GHz band is allocated to the fixed, fixed-satellite (Earth-to-space), mobile, and radio astronomy services on a primary basis; and the band 81-84 GHz is additionally allocated to the mobile-satellite service (Earth-to-space) on a primary basis and to the space research service (space-to-Earth) on a secondary basis. All of these allocations will be available for both Federal and non-Federal Government use.

18. With respect to amateur and amateur-satellite service operations at 81-81.5 GHz, commenters oppose a secondary allocation.[56] As noted above, we conclude that the primary allocation at 77.5-78 GHz already provides sufficient spectrum for amateur and amateur-satellite services in this frequency range. Moreover, allowing amateur operations to share with commercial operations could complicate frequency coordination because this band will be used by commercial operations, which require reliability, to pair with the 71-76 GHz band if such use is needed.

19. Commenters' replies to the Commission's request for comments regarding sharing of the 81-86 GHz band were the same or similar to those discussed *supra* for the 71-76 GHz band allocation,[57] and

[50] *Id.* The Commission also proposed to delete the requirement in footnote 5.561 that fixed, mobile, and broadcasting in the 84-86 GHz band not cause harmful interference to BSS. *Id.* at 12,195 ¶ 34.

[51] *Id.* at 12,194 ¶ 30.

[52] *Id.* at 12,194 ¶ 31.

[53] *Id.* at 12,194 ¶ 32.

[54] *Id.*

[55] *See supra* ¶ 10.

[56] FWCC Comments at 5-6; Sprint Comments at 4; WCAI Comments at 8.

[57] Cisco Comments at 12-13; Loea Reply at 5-6.

we are also persuaded that it is too early to draw reliable conclusions about frequency sharing in this band.[58] Historically technology needs to mature to produce actual data on actual interference conditions. These frequencies pose less of an interference problem potential than lower microwave frequencies, due to the high attenuation to which they are subject, and their particular characteristics. Also, we do not know which typical levels of EIRP will be actually used by the industry. Adopting premature parameters could have a negative impact by slowing down the development of the band and manufacture of equipment. Therefore, we arrive at the same conclusions for the 81-86 GHz band as we did concerning the 71-76 GHz band, and will maintain multiple services in the allocation table for the 71-76 GHz band, but will address possible sharing criteria in the future. We also delay any action regarding the BSS and broadcasting allocations for the 84-86 GHz band because, as of yet, we do not have reliable evidence that demonstrates whether the provision of such services is suitable for this band.

3. 92-95 GHz

20. *Background.* WRC-97 allocated the 94-94.1 GHz band to the Earth exploration-satellite service (EESS) and SRS for active sensor operations,[59] and limited the use of these allocations to spaceborne cloud radars.[60] The fixed, mobile, and FSS uplink allocations were deleted from the 94-94.1 GHz band. At WRC-2000, the 94-94.1 GHz band was allocated to the RAS on a secondary basis, and the 92-94 GHz and 94.1-95 GHz bands were allocated to the RAS on a primary basis.[61] The FSS uplink allocations in the 92-94 GHz and 94.1-95 GHz bands were deleted.

21. In the *NPRM,* the Commission proposed to implement the *WRC-97 Final Acts* and *WRC-2000 Final Acts* with respect to the 92-95 GHz band.[62] Specifically, it proposed to allocate the 92-94 GHz and 94.1-95 GHz bands to the RAS on a primary basis. The Commission also proposed to allocate the 94-94.1 GHz band to the EESS (active) and SRS (active) on a primary basis for Federal Government use, limited to cloud radars, to allocate the 94-94.1 GHz band to the RAS on a secondary basis, and to delete the fixed and mobile allocations from that band.[63] In addition, it proposed to delete the FSS uplink allocation from the 92-95 GHz band.[64] Consistent with international footnote 5.149, the Commission proposed to revise footnote US342 to add the 92-94 GHz and 94.1-95 GHz bands to the list of frequency bands wherein all practicable steps are to be taken to protect the RAS from harmful interference when assignments to stations of other services are made.[65]

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[58] Cisco Comments at 16; NTIA Reply at 7; Terabeam Reply at 10-11.

[59] An active sensor is an EESS or SRS measuring instrument by means of which information is obtained by transmission and reception of radio waves. *See* 47 C.F.R. § 2.1.

[60] *NPRM,* 17 FCC Rcd at 12,189 ¶ 12, 12,196 ¶ 37.

[61] *Id.* at 12,196 ¶ 38.

[62] *Id.* at 12,196 ¶ 40.

[63] *Id.*

[64] *Id.*

[65] *Id.* at 12,196-97 ¶ 41.

22. *Discussion.* Commenters support the Commission's proposals.[66] NTIA supports full sharing of the band and finds that it is unnecessary to partition the band; it also supports the proposed revisions to the National Table of Frequency Allocations summarized in the *NPRM*.[67] NTIA indicates that NASA currently has in place a prototype cloud-profiling radar operation.[68] Accordingly, NTIA supports the allocation of the 94-94.1 GHz band to the space research service. We agree that these changes are appropriate, and will avoid interference to important scientific research. Consequently, we adopt the proposed changes to the U.S. Table. Accordingly, the 92-94 GHz and 94.1-95 GHz bands are allocated to the fixed, mobile, radio astronomy, and radiolocation services on a primary basis. The 94-94.1 GHz band is allocated to the Earth exploration-satellite (active), space research (active), and radiolocation services on a primary basis and to the radio astronomy service on a secondary basis. All of these allocations are available for Federal and non-Federal Government use, except for the EESS (active) and SRS (active) allocations, which are limited to Federal Government spaceborne cloud radar use.

4. RAS Protection in the 81-86 GHz, 92-94 GHz, and 94.1-95 GHz Bands

23. *Background.* In the *NPRM,* the Commission noted that it had proposed to allocate the 81-86 GHz, 92-94 GHz, and 94.1-95 GHz bands to the RAS on a primary basis, but in order to implement the WRC-2000 allocations, it also sought comment on whether, given the primary RAS allocation in the 86-92 GHz band, the entire proposed RAS allocation was necessary. The Commission also sought comment on how to avoid interference to the eighteen receive only RAS observatories that currently receive in the 81-86 GHz, 92-94 GHz, and 94.1-95 GHz bands.[69]

24. The customary means of protecting RAS reception is through coordination around RAS observatories. The Commission tentatively proposed to adopt a proposal by the National Science Foundation (NSF) to require coordination by all other allocated sources within coordination radii of the order of 150 kilometers around the eight single dish observatories, and 25 kilometers around the ten Very Long Baseline Array (VLBA) stations.[70] The Commission also requested comment on how to minimize any coordination burden on relevant parties.[71] In particular, it sought comment on whether to require RAS observatories to operate a web site where fixed point-to-point licensees can input end points of links, power, and antenna characteristics and promptly receive a determination whether coordination is required. The web site would take into account the observatory sensitivity, terrain shielding, and the azimuth of the path relative to the observatory.[72] In the alternative, the Commission sought comment on whether to geographically limit the scope of these RAS allocations in a similar fashion to the RAS

[66] *See, e.g.,* Sprint Comments at 4-5; WCAI Comments at 9.

[67] NTIA Reply at 2-3.

[68] *Id.* at 9.

[69] *NPRM,* 17 FCC Rcd at 12,197-98 ¶ 44.

[70] *See id.* at 12,198 ¶ 45; *see id.* at 12,244 for the list of RAS telescopes that would be protected under this proposal.

[71] *See id.* at 12,198 ¶ 45.

[72] *Id.* This approach is similar to the coordination method that was developed for the 1670-1675 MHz Government transfer band, whereby the National Oceanic and Atmospheric Administration maintains a web site (http://www.osd.noaa.gov/radio/frequency.htm) to assist in coordination near two of its receive earth stations. *See* 47 C.F.R. § 1.924(f)(1).

allocation in the 10.6-10.68 GHz band, which provides that the RAS will not receive protection from stations in other allocated services that are licensed to operate in the one hundred most populous urbanized areas as defined by the U.S. Census Bureau.[73]

25. *Discussion.* In general, commenters such as The National Radio Astronomy Observatory (NRAO), FWCC, the National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (NAS), and WCAI supported the allocations made at WRC-2000 for these bands and retaining primary status for RAS.[74] As the Commission recognized in the *NPRM,* radio astronomers must observe radio waves of cosmic origin at frequencies over which they have no control.[75] We understand that due to the extremely low levels of the signals to be observed, sharing a frequency band with other services which operate at thousands of times higher levels poses a unique challenge. We agree that adequate protection methods must exist for the RAS to operate, and, consequently, we allocate the 81-86 GHz and the 92-95 GHz (except 94-94.1 GHz) segments of the band for RAS operations on a co-primary basis.

26. With respect to coordination procedures, some commenters, such as NTIA, Cisco, Terabeam and Loea support the customary coordination around RAS observatories and the adoption of the NSF approach.[76] NAS and NRAO also support it, but advocate using a 60 kilometer radius around the VLBA stations. They indicated that this would be consistent with the value for the same set of RAS sites in the table in Section 101.31 of the Commission's Rules.[77] However, we are aware that NSF is developing revised interference protection criteria between RAS and the other services in the 81-86 GHz and 92-95 GHz segments of the band that are anticipated to take into account the observatory sensitivity, terrain shielding, and the azimuth of the path relative to the observatory.[78] We understand that the NTIA intends to include non-Federal Government Radio Astronomy sites in its planned automated mechanism for coordination purposes (discussed *infra*). To this end, we delegate authority to the Wireless Telecommunications Bureau and the Office of Engineering and Technology to interface with NSF and NTIA and to take whatever action is necessary to implement appropriate RAS interference protection, as

[73] *NPRM,* 17 FCC Rcd at 12,199 ¶ 46 (citing 47 C.F.R. § 2.106 n.US277).

[74] NRAO Comments at 1; FWCC Comments at 4; NAS Comments at 4; WCAI Comments at 9 and 10 (with the caveat that RAS be secondary in the 94-94.1 GHz segment).

[75] *NPRM,* 17 FCC Rcd at 12,198 ¶ 44. The radio frequencies of interest for the RAS depend on the characteristics of the object studied. Celestial radio sources radiate radio waves varying with time and frequency, with intensity and polarization determined by their physical conditions. Each part of the radio spectrum gives specific information about a source. Radio astronomers have to follow the constraints on frequency selection imposed by nature. A similar situation holds for atmospheric studies based on observations of atmospheric gases. These gases generate radio emissions at one or more discrete frequencies called a spectral line. These spectral lines are often of interest for radio astronomers. In addition, various RAS projects depend on measurements of broadband or continuum emission. *See* International Telecommunication Union Handbook on Radio Astronomy 5-9 (Working Party 7D of ITU-R Study Group 7, eds., *1995*).

[76] NTIA Reply at 10; Cisco Reply at 12; Terabeam Reply at 3; Loea Reply at 24-25.

[77] 47 C.F.R. § 101.31; NAS Comments at 7; NRAO Comments at 2.

[78] Loea Reply at 24; NTIA Reply at 11-14.

well as coordination procedures regarding other users,[79] if, contrary to expectations, NSF and NTIA fail to finalize revised interference criteria and to include non-Federal Government radio astronomy sites in its planned automated mechanism.

B. Band Plan

1. 71-76 GHz and 81-86 GHz Bands

27. *Background.* The 71-76 GHz and 81-86 GHz bands are allocated on a co-primary basis for Federal Government services.[80] In the *NPRM,* the Commission considered protection for co-primary services in the event Federal Government or satellite operators seek to use these bands in the future.[81] In addition, it found that the bands adjacent to the 71-76 GHz and 81-86 GHz bands, especially the 86-92 GHz passive band, may require protection.[82]

28. The Commission sought comment on Loea's proposal to authorize the entire 71-76 GHz and 81-86 GHz bands for fixed use.[83] The Commission specifically sought comment on whether Loea's band plan proposal for the 71-76 GHz and 81-86 GHz bands provides adequate protection for the Federal Government and non-Federal Government services that share the bands on a co-primary basis.[84] It also sought comment on the extent to which it should implement sharing criteria between fixed services and other services authorized for the bands.[85] Further, the Commission sought comment on whether Loea's proposed band plan for the 71-76 GHz and 81-86 GHz bands provides adequate protection for the adjacent bands, especially the passive 86-92 GHz band.[86] Lastly, the Commission also invited commenters to propose alternative band plans for this spectrum that would provide flexibility and efficient spectrum usage while providing adequate protection for the co-primary users described above.[87] It asked them to consider the bands adjacent to the 71-76 GHz and 81-86 GHz bands.[88]

29. *Discussion.* The majority of commenters support Loea's band plan, which consists in assigning the totality of the available spectrum in the 71-76 GHz and 81-86 GHz to each licensee.[89] The

[79] *See* License Coordination, *infra* at ¶¶ 47-57. Regarding the coordination procedure, we understand that NTIA is willing to consider including non-Federal Government RAS sites on its planned database for coordination purposes (discussed *infra*).

[80] 47 C.F.R. § 2.106.

[81] *NPRM,* 17 FCC Rcd at 12,203 ¶ 57.

[82] *Id.*

[83] *See* Loea Petition at 10.

[84] *NPRM,* 17 FCC Rcd at 12,205 ¶ 60.

[85] *Id.*

[86] *Id.*

[87] *Id.* at 12,205 ¶ 61.

[88] *Id.*

[89] *See, e.g.,* Sprint Comments at 5; WCAI Comments at 11; Cisco Reply at 13; Joint Parties Reply at 2; Loea Reply at 19; FWCC Comments at 9; Harris Comments at 5; Terabeam Reply at 6-9.

Joint Parties propose that the 71-76 and 81-86 GHz bands should be designated as paired channels, such that transceivers operating in these bands will transmit in one channel only and receive in the other.[90] Harris disagrees with the proposal to require pairing of the 71-76 GHz band with the 81-86 GHz band, and recommends instead that the bands be licensed optionally separately or together.[91]

30. Commenters generally believe that non-Federal Government use of the 71-76 GHz and 81-86 GHz bands will likely be for point-to-point, common carrier quality, last mile and first mile connections (instead of copper or fiber pairs).[92] Personal Broadband Wireless Access Networks connected to small and large enterprises in underserved and unserved markets,[93] consumer-priced WiFi devices for homes or more sophisticated equipment for universities and corporations, Wireless Local Area Networks,[94] and unlicensed wireless devices[95] were other possible uses for the spectrum mentioned by commenters to the *NPRM*.

31. Based on the record in this proceeding, we are not persuaded that in every instance licensees will require five gigahertz of bandwidth in each direction to provide the services described above. Commenters such as Loea view the 71-76 GHz, 81-86 GHz and 92-95 GHz (70-80-90 GHz) spectrum as a possible substitute for fiber optic communications in those places where it is unpractical to dig to lay fiber optic cable, rather than as a substitute for the traditional uses such as telephony, DS-1 and TV relay.[96] Because this is the case, we note that, assuming the spectrum is used at a one bit per Hertz efficiency rate, one OC-3 signal would occupy only 3.12% of a five gigahertz segment; and can accommodate 1,920 voice channels or data of up to 155.52 Megabits per second (Mbps). Furthermore, one OC-48 signal, which equals three OC-3 signals, would occupy less than half (49.76%) of five gigahertz, and would be capable of carrying data of up to 2.488 Gigabits per second (Gbps). Moreover, the importance of allowing competition, when providing this type of broadband-high speed services to customers, especially in heavily populated areas, warrants segmentation. We therefore conclude that we should adopt a frequency utilization plan based on units smaller than 5 GHz, as explained below. Such a plan will encourage efficiency because users will not have excess bandwidth, maximize spectrum re-use because more than one provider may be able to use the same land microwave path, and facilitate coordination among users because smaller bandwidth with the same power density has less potential of generating harmful interference than broader bandwidth.[97]

32. Specifically, we will segment the 71-76 GHz and 81-86 GHz bands. We believe that licensing the spectrum in building blocks of 1.25 GHz increments provides ample capacity by today's standards and the flexibility for technological development because it makes it possible to justify the use

[90] Joint Parties Reply at 4.

[91] Harris Reply at 3.

[92] Loea Reply at 1; Endwave Comments at 2 & 5; Harris Comments at 1.

[93] I-Fi, LLC/BGI Comments at 1; K.C.C. Inc. Comments at 1.

[94] Cisco Comments at 6.

[95] Wi-Fi Alliance Comments at 2.

[96] *See, e.g.*, Loea Comments at 3, 5.

[97] *Cf.* The 4.9 GHz Band Transferred from Federal Government Use, *Memorandum Opinion and Order and Third Report and Order*, WT Docket No. 00-32, 18 FCC Rcd at 9152, 9156-57 ¶¶ 38-40 (2003) (*4.9 GHz Third R&O*).

of up to the full 10 GHz by combining these blocks. We note that virtual fiber[98] today is reported to be carrying data in the range of 1.25 Gbps, and expected to approach 2.5 Gbps in the near future.[99] The proposed band segmentation easily accommodates these building blocks, and allows them to be combined to occupy up to 10 GHz of spectrum. In order to maximize the number of possible users at a given location, we will divide the 71-76 GHz and 81-86 GHz bands into unpaired 1.25 GHz segments (without mandating specific channels within the segment) with no aggregation limit. We will permit pairing, but only in a standardized manner (*e.g.*, 71-72.25 GHz may be paired only with 81-82.25 GHz, and so on). This band segmentation provides the flexibility for licensees to choose how much spectrum to use, thus promoting competition by making it possible for more than one provider to use different segments of the band, should more than one provider need to use the same microwave path to reach the same segment of the population.

2. 92-95 GHz Band

33. *Background.* In the *NPRM,* the Commission requested comment on three band plans for the 92-95 GHz band.[100] Under Band Plan I, the Commission would license the 92.3-93.2 GHz and 94.1-95 GHz spectrum blocks for commercial use.[101] Primary Federal Government assignments would be made in the 92-92.3 GHz and 93.2-94.1 GHz spectrum blocks throughout the nation. In addition, primary Federal Government assignments could be authorized in the licensed non-Federal Government bands at designated military installations. Outside the designated military installations, the Commission proposed that Federal Government assignments would be authorized in the licensed non-Federal Government bands on a secondary basis. Band Plan I would also make the 92-95 GHz band available for unlicensed Part 15 use on a secondary basis in the primary Federal Government bands (92-92.3 GHz and 93.2-94.1 GHz). Band Plan II shares many of the characteristics of Band Plan I as it also divides the primary Federal Government spectrum from the primary non-Federal Government spectrum, but the segmentation of the band is different.[102] Another option, Band Plan III, proposed by Boeing, provides licensees in the 92-95 GHz band with access to 2,900 megahertz of spectrum (92-94 GHz and 94.1-95 GHz), which is all

[98] "Virtual fiber" is a term used by some in the communications industry to describe bandwidth segments in the microwave bands capable of carrying the same amount of data as fiber optic cable. The capacity and loading requirements specified in our rules in Section 101.141 (a) (3) show that in such microwave bands as the 6 GHz or 11 GHz, the bandwidth segments of 0.4 to 40 MHz have a typical utilization of 1.54 to 134.1 Mbits/sec or the equivalent of 1 DS-1 to 3 DS-3 lines. In fiber optics, and in these higher 70/80/90 GHz microwave bands, greater bandwidth segments than 40 MHz are afforded (5,000 MHz is possible here), and the typical utilization is one or more OC-3 signals (155.52 Mbits/sec per OC-3 signal). Because of the similarity in data carrying capacity between fiber optics and the 70/80/90 spectrum the term "Virtual fiber" was coined.

[99] Letter dated Mar. 19, 2003 from Thomas Cohen, The KDW Group, to Marlene H. Dortch, Secretary, Federal Communications Commission, at 9 (Slide #7 of March 19, 2003 Presentation to the FCC by Louis Slaughter, CEO Loea Comm. Corp.).

[100] *NPRM,* 17 FCC Rcd at 12,199-205 ¶¶ 47-61.

[101] *Id.* at 12,200 ¶ 50.

[102] *Id.* at 12,202 ¶ 55. Both Plan I and Plan II assign the same amount of spectrum on a primary basis to Federal Government (1.2 GHz) and non-Federal (1.8 GHz), but in different parts of the spectrum. In Plan II, the primary assignments for the Federal Government would be the 92.0-92.6 GHz and 93.5-94.1 GHz bands.

of the 92-95 GHz band that can be allocated to the fixed and mobile services.[103] Federal and non-Federal licensees would share the spectrum on a co-primary basis.

34. *Discussion.* NTIA welcomes shared use of the band by commercial entities, but with no restriction to the essential Federal Government radiolocation service use of the band.[104] While the Federal Government desires to share the band to the maximum degree possible, NTIA explains that Federal Government systems cannot operate on a secondary basis or be restricted to operate only on Federal Government property.[105] For example, according to the NTIA, current and planned Federal Government systems operating in the 92-95 GHz have bandwidths that exceed the Federal Government primary segments proposed in Band Plans I and II, and Federal Government radiolocation operations will occupy these segments of the band. NTIA indicates that Federal Government use of the band will be for both military and federal civil agency applications.[106] Because the extent and location of future Federal Government operations in this band cannot be precisely defined at this time, the NTIA believes that coordination must be required for successful sharing.[107]

35. Other commenters generally discussed the band plan for 92-95 GHz. Joint Parties,[108] for example, did not specifically propose a band plan, but generally advised that only minimal segmentation of the 92-95 GHz band should be made, where necessary to protect the 94.0-94.1 GHz cloud radar band.[109] In addition, Boeing stated that the Commission should adopt a band plan to allow diverse technologies to reuse the same scarce spectrum.[110] Also, Sprint believes that Band Plan III will support the widest range of new uses.[111]

36. The record before us also shows that there is considerable interest in using the 92-95 GHz band for unlicensed, Part 15 devices.[112] For example, the FWCC points out that unlicensed devices are ideal for a wide range of applications which require low cost or rapid installation and successfully underlay other applications in the same spectrum.[113]

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[103] *Id.* at 12,202-03 ¶ 56.

[104] NTIA Reply at 15.

[105] *Id.*

[106] *Id.*

[107] *Id.*

[108] Joint Parties Reply comprises the reply comments of Loea, Cisco, Endwave Corporation, Ceragon Networks, BridgeWave Communications, Inc., and Stratex Networks (Joint Parties).

[109] *Id.* at 2.

[110] Boeing Comments at 3.

[111] Sprint Comments at 5.

[112] FWCC Comments at 7; Wi-Fi Comments at 3; WCAI Comments at 12; NTIA Reply at 10 (NTIA explains that NSF states that Part 15 devices pose no sharing problems for U.S. radio astronomy facilities under any of the band plans listed in the *NPRM,* so long as these devices are limited to indoor use and preclude airborne applications); Comsearch Reply at 2; NAS Comments at 9.

[113] FWCC Comments at 7.

37. We conclude that Band Plan III best accommodates the concerns of NTIA and the non-Federal Government commenters. Under that plan, Federal Government users will have access to the entire band nationwide on a co-primary basis. Non-Federal Government licensees also will have access to the maximum possible part of the band, also on a co-primary basis. In addition, Band Plan III provides the greatest opportunity for unlicensed use. Consequently, we adopt this plan. Non-Federal Government licensees will be permitted to use either or both of the two co-primary segments (92.0-94.0 GHz and 94.1-95.0 GHz) for point-to-point services under Part 101. In addition, we will allow unlicensed Part 15 devices in the co-primary segments.[114] We also find that the services in this band will be technically compatible with the operation of Federal radiolocation services. If any interference issues unexpectedly develop, we will work with the NTIA to find jointly acceptable solutions. Rules for unlicensed devices, and coordination procedures between non-Federal Government licensees and Federal Government users, are addressed later in this *Report and Order.*

C. Rules for Unlicensed Devices

38. *Background.* In the *NPRM,*[115] the Commission proposed to make the 92-95 GHz band available for unlicensed use and set forth proposed rules[116] that are based on existing regulations for the 57-64 GHz band.[117] It determined that power levels for 57-64 GHz unlicensed operation are also appropriate for 92-95 GHz because they were based primarily on safety issues with respect to power densities.[118] The Commission set forth proposed rules that were structured to be as flexible as possible with no restrictions on the types of modulation or applications, except that these devices may not be used in aircraft or satellites.[119] The Commission found that this prohibition on airborne and spaceborne use is necessary to protect in-band RAS observations.[120]

39. The Commission also sought comment on providing for operation of unlicensed devices in the 71-76 GHz and 81-86 GHz bands.[121] In the *NPRM,* the Commission reasoned that unlicensed use of this spectrum could provide additional bandwidth for high capacity, short-range communications and other new and unique communications applications.[122]

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[114] Part 15 devices are prohibited from causing harmful interference to, and must accept interference from, other operations. *See* 47 C.F.R. § 15.5(b); *see also infra* ¶ 40.

[115] *NPRM,* 17 FCC Rcd at 12,205 ¶ 62.

[116] *Id.* at 12,237 (Appendix B).

[117] 47 C.F.R. § 15.255.

[118] As shown in Appendix B, the proposed power levels are 9 $\mu W/cm^2$ average power and 18 $\mu W/cm^2$ peak power, both measured 3 meters from the radiating structure.

[119] This flexibility follows the precedent set in 47 C.F.R. § 15.407(e) for the Unlicensed National Information Infrastructure band.

[120] *NPRM,* 17 FCC Rcd at 12,205 ¶ 62; *see* 47 C.F.R. § 15.255(a).

[121] *NPRM,* 17 FCC Rcd at 12,206 ¶ 63.

[122] *Id.*